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# MADROÑO

## A WEST AMERICAN JOURNAL OF BOTANY

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# MADROÑO

## A WEST AMERICAN JOURNAL OF BOTANY

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# A SYNOPSIS OF THE AMERICAN SPECIES OF CICUTA

Mildred E. Mathias and Lincoln Constance

The water hemlocks are of especial interest because of their poisonous properties, which make them a menace both to livestock and human beings. In a recent paper, Bomhard (1) remarks that, "The extremely toxic character of the underground parts ranks this genus as one of the most virulently poisonous groups of flowering plants native to the North Temperate Zone." Hence, a great deal of space has been devoted to them in agricultural bulletins, some of which have directed considerable attention to the specific differences allegedly discernible in the subterranean portions of the plants. It is the purpose of the present paper to evaluate the characters which have been used to delimit species in the genus, and to propose a somewhat revised taxonomic treatment. Specific descriptions for *Cicuta* will appear in a forthcoming number of "North American Flora."

In their pioneer revision of North American Umbelliferae in 1888, Coulter and Rose (2) referred the known members of the genus in America to three species, the European *Cicuta virosa* L. (with two varieties), *C. Bolanderi* Gray, a plant endemic to the California salt marshes, and *C. bulbifera* L. *Cicuta bulbifera,* easily separable from the other species by virtue of the usually asexual reproduction through the agency of bulblets in the axils of the upper foliage leaves, will not enter into the following discussion. This rather simple picture of the genus was upset the following year by Greene (4), who excluded *C. virosa* from America, and described three additional species from the western United States, *C. occidentalis, C. purpurata,* and *C. vagans.* At the same time, he enunciated his faith in the value of vegetative characters in distinguishing the species of water hemlocks in the following words: "In the few families of plants which are, like the Umbelliferae, preëminently natural, the anthological and carpological characters, whether of genera or of species, are apt to be very slight. But here Nature comes usually to the rescue of the despairing carpological systematist, and gives him good characters for his genera, or for his species, in the vegetative organs. Only by regarding these latter can a man set good limits to species in such a genus as *Cicuta.*"

Again, in November of the same year, he re-emphasized (5) and elaborated this view, as follows: "The fact is well recognized, or should be, by descriptive botanists, that in herbaceous plants of all kinds, characters of the roots or other subterranean organs are of the very best for specific distinctions. Those of pubescence, foliage, and to some extent, of the flower also, are less constant within specific limits than are the peculiarities of the root, when the root happens to have peculiarities, which is however by

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no means the rule in nature. Most commonly the roots, rhizomes, tubers and other such organs will be much the same throughout the whole group—a long series of species, or even an entire genus. In an order so extremely natural as that of the Umbelliferae, in which the fruits are so similar that plants of the same carpology are sometimes placed in different genera in deference to merely vegetative differences, it would seem altogether unphilosophical to require of the fruit that it furnish specific characters; or, to assume that unless the supposed members if a genus can be distinguished carpologically the species is but one."

Coulter and Rose, in their later treatment of the Umbelliferae (3), accepted two of the three species Greene had described, but judged *C. purpurata* to be conspecific with *C. Douglasii* (DC.) C. & R. They added to the list of species *C. Curtissii,* conspecific with *C. mexicana* which they had already described earlier in the same year. Although they accepted Greene's species, they were not entirely convinced of the validity of the characters he had originally employed in distinguishing them: "We reproduce the above key in the hope that it may be further tested in the field, for with the material at our command we have not been able to follow it fully. While we recognize in Professor Greene's typical material the differences suggested, we do not find them constant. The fleshy thickening of the rootstocks and their direction, as well as the thickness and elongation of the roots, seem to vary with the nature of the substratum, as might be expected." The synoptical key offered by Greene, modified by the inclusion of the species he later described follows.

* Root axis very short, nearly or quite erect, not enlarged, its partitions crowded.
  + Roots all alike, slender fibrous.
    *C. virosa.*
  ++ Main roots coarse, elongated, fleshy fibrous.
    *C. Bolanderi, C. occidentalis, C. purpurata, C. frondosa, C. arguta, C. Sonnei.*
  +++ Main roots oval or oblong, fleshy tuberiform.
    *C. maculata, C. bulbifera, C. subfalcata.*

** Rhizomatous species; the root axis greatly enlarged, horizontal, only partly or not at all subterranean, emitting fibrous roots from beneath.
    *C. vagans, C. californica, C. grandifolia, C. dakotica.*

Incapable of placement in this scheme are the three following species, also described by Greene: *C. valida,* "stature of the plant and its underground parts not known"; *C. fimbriata,* described only from the foliage; *C. ampla,* "known to me only in the fruiting summit of a single plant."

EXPLANATION OF THE FIGURES. PLATE 14.

PLATE 14. FRUITS OF CICUTA. Longitudinal view (× 6.5) and cross section (× 9.5). FIGS. 1, 2, *C. Bolanderi;* 3, 4, *C. virosa;* 5, 6, *C. mexicana;* 7, 8, *C. Douglasii;* 9, 10, *C. Victorinii;* 11, 12, *C. mackenzieana;* 13, 14, *C. maculata.*

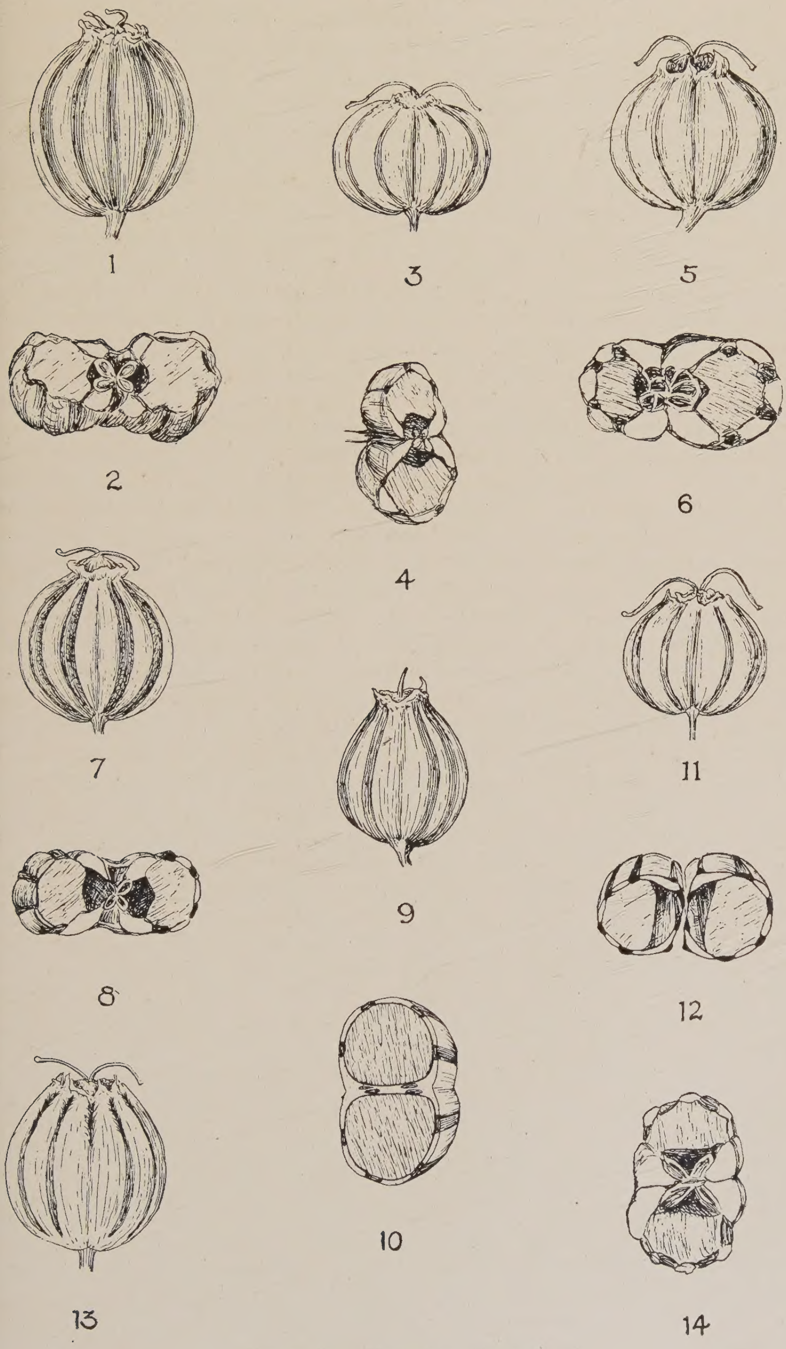

Plate 14. Fruits of Cicuta.

Illustrating their scepticism of the very foundation of Greene's classification, Coulter and Rose proceeded to base their own key on their observation that the "species seem to be best grouped primarily by their oblong or orbicular fruits, further separation being made upon differences in the fruit ribs and in the foliage." Greene, however, seems not to have been at all discouraged and described *C. grandifolia* in 1907, and *C. frondosa, C. subfalcata, C. dakotica, C. arguta, C. valida, C. Sonnei, C. fimbriata* and *C. ampla* in 1912. *Cicuta cinicola* A. Nels. was added from Idaho, also in 1912, and recently *C. mackenzieana* Raup has been described from northern Canada and *C. Victorinii* Fernald from the mouth of the St. Lawrence River. Authors of manuals and floras have not been prone to accept Greene's second deluge of segregates, but have admitted *C. occidentalis* or *C. vagans* or both to their treatments of the appropriate areas.

In preparing a revision of this genus for our account of the Umbelliferae in the "North American Flora," we have had occasion to re-examine the material on which Greene based his conclusions. We are in agreement with him that *Cicuta virosa* is to be excluded from North America, although its relationship to *C. mackenzieana* appears to be rather close. We question the whole thesis that the underground parts of the water hemlocks afford specific characters, at least of the nature noted by Greene, and believe that they are so susceptible of modification in relation to soil composition and fertility, and especially to soil aëration, as to be essentially useless in this connection. Furthermore, we are unable to attach sufficient importance to the degree of leaf-division to warrant the retention of *C. californica* as distinct from *C. Douglasii,* and find that Coulter and Rose's distinction between "oblong" and "orbicular" fruits sometimes breaks down on the same plant. The diagnostic value of leaf-venation as a means of distinguishing *Cicuta* from other umbelliferous genera, and also for separating individual species in the former genus, has been stressed recently by Bomhard (1). She distinguishes *C. californica* from the other species by the fact that the secondary veins of the leaflets are directed at the marginal teeth, rather than at the sinuses between them. Our studies, however, have not enabled us to find any marked difference in this entity, which would warrant its continued retention as a species.

On the other hand, characters of the fruit, especially its compression, the proportion between the dorsal and lateral ribs, their relation to the intervals, and the nature of the oil tubes and the seed do seem to enable us to distinguish natural species in the genus. Our treatment, admits the following species for North America: *C. Bolanderi, C. mexicana, C. Douglasii, C. mackenzieana, C. maculata, C. Victorinii* and *C. bulbifera.* All of the species proposed by Greene will thus be relegated to the synonymy which they appear richly to deserve.

## TAXONOMIC TREATMENT

CICUTA L. Sp. Pl. 1: 255. 1753. *Cicutaria* Lam. Fl. France 3: 445. 1778. *Keraskomion* Raf. New. Fl. Amer. 4: 21. 1836. Type species: *Cicuta virosa* L.

- Axils of the leaves not bulbiferous.
  - Fruit constricted at the commissure; lateral ribs about equalling the dorsals in surface display.
    - Oil tubes large (pl. 14, figs. 2, 6); seed oily, evidently channeled under the tubes.
      - Ribs narrower than the oil tubes: plants of Pacific Coast salt marshes . . . . . . . . 1. *C. Bolanderi.*
      - Ribs broader than the oil tubes; plants of coastal eastern and southeastern United States and eastern Mexico . . . . . . . . 2. *C. mexicana.*
    - Oil tubes small (pl. 14, figs. 8, 12); seed less oily, unchanneled or only slightly channeled under the tubes.
      - Fruit oval to orbicular, at least as long as broad, 2–4 mm. long, 2–3 mm. broad; rays 12–20, 2–6 cm. long; pedicels 3–8 mm. long . . . . . . . . 3. *C. Douglasii.*
      - Fruit elliptical, conspicuously broader than long, 1.5–2.2 mm. long, 2–3 mm. broad; rays 7–14, 7–8 cm. long; pedicels 7–12 mm. long . . . . . . . . 4. *C. mackenzieana.*
  - Fruit not constricted at the commissure; lateral ribs much broader than the dorsal in surface display.
    - Leaflets coarsely serrate to incised; fruit oval to orbicular, rounded at apex and base; lateral ribs prominent, about equalling the intervals . . . . . . . . 5. *C. maculata.*
    - Leaflets finely serrate; fruit ovate, narrowed toward apex, cordate at base; lateral ribs obscure, much narrower than the intervals . . . . . . . . 6. *C. Victorinii.*
- Axils of the leaves bulbiferous . . . . . . . . 7. *C. bulbifera.*

1. CICUTA BOLANDERI Wats. Proc. Amer. Acad. 11: 139. 1876.

Type locality. Suisun, Solano County, California, in salt marshes, *Bolander.*

Distribution. Salt marshes of central and southern California.

Representatives. *Davy 4106, 6668, 6789, 6877; Heller 7541.*

2. CICUTA MEXICANA Coult. & Rose, Proc. Wash. Acad. 1: 145. (January) 1900. *C. maculata* L. *sensu* Hemsl. Biol. Centr.-Amer. Bot. 1: 566. 1879–81, not *C. maculata* L. 1753. *C. Curtissii* Coult. & Rose, Contr. U. S. Nat. Herb. 7: 97. (December) 1900. *C. maculata* var. *Curtissii* Fern. Rhodora 41: 439. 1939.

Type locality. Coatzacoalcos, Isthmus of Tehuantepec, Vera Cruz, *Chas. L. Smith 1161.*

Distribution. New Jersey to Florida, south and west to Tamaulipas, Nuevo Leon and Vera Cruz.

Representatives. *Curtiss 6845; Heller 1165; Palmer 445; Pringle 10,804.*

3. CICUTA DOUGLASII (DC.) Coult. & Rose, Contr. U. S. Nat. Herb. 7: 95. 1900. *Sium Douglasii* DC. Prodr. 4: 125. 1830. *Cicuta maculata* L. *sensu* Hook. & Arn. Bot. Beechey Voy. 142. 1841, not L. 1753. *C. californica* Gray, Proc. Amer. Acad. 7:

344. 1867. *C. crassifolia* Nutt. Rept. Wilkes Exped. 17: 316. 1874. *C. virosa* var. *californica* Coult. & Rose, Rev. N. Amer. Umbel. 130. 1888. *C. occidentalis* Greene, Pittonia 2: 7. 1889. *C. occidentalis* f. *frondosa* Greene, *op. cit.* p. 7. *C. purpurata* Greene, *op. cit.* p. 8. *C. vagans* Greene, *op. cit.* p. 9. *C. grandifolia* Greene, Leafl. Bot. Obs. 2: 124. 1909. *C. Douglasii* var. *occidentalis* Jones, Bull. Univ. Mont. Biol. ser. 15, 42. 1910. *C. Sonnei* Greene, Leafl. Bot. Obs. 2: 239. 1912. *C. subfalcata* Greene, *op. cit.* p. 237. *C. frondosa* Greene, *op. cit.* p. 236. *C. valida* Greene, *op. cit.* p. 238. *C. fimbriata* Greene, *op. cit.* p. 240. *C. cinicola* A. Nels. Bot. Gaz. 54: 141, fig. 1. 1912. *C. occidentalis* f. *californica* Wolff ex Engl. Pflanzenr. $4^{228}$: 90: 82. 1927. *C. occidentalis* f. *oregonensi-idahoensis* Wolff, *op. cit.* p. 82. *C. occidentalis* f. *arizonensis* Wolff, *op. cit.* p. 82. *C. occidentalis* f. *wyomingensis* Wolff, *op. cit.* p. 82.

Type locality. "In America boreali-occid.," *Douglas.*

Distribution. Alberta and Montana to western Alaska, south to California, New Mexico, Arizona and Chihuahua.

Representatives. *Baker 655; Brown 501; Cusick 2556, 2779; Heller 7174; Nelson & Macbride 1315; Townsend & Barber 57.*

4. **Cicuta mackenzieana** Raup, Journ. Arn. Arb. 17: 279, pl. 197. 1936.

Type locality. Sandy margin of a lagoon near the south shore of Lake Athabaska about 1.5 miles west of Ennuyeuse Creek, Canada, August 25, 1935, *Raup 6976.*

Distribution. Hudson Bay to the Mackenzie Basin.

Representatives. *Macoun 79,261; Raup 6764, 6964.*

5. **Cicuta maculata** L. Sp. Pl. 1: 256. 1753. *C. maculata* Lam. Encycl. 2: 2. 1786. *C. virosa* var. *maculata* Coult. & Rose, Rev. N. Amer. Umbel. 130. 1888. *C. dakotica* Greene, Leafl. Bot. Obs. 2: 237. 1912. *C. arguta* Greene, *op. cit.* p. 238. *C. ampla* Greene, *op. cit.* p. 241. *C. dakotica* var. *pseudovirosa* Lunell, Amer. Midl. Nat. 4: 486. 1916. *C. dakotica* var. *pseudomaculata* Lunell, *op. cit.* p. 486.

Type locality. Virginia, *Kalm.*

Distribution. Prince Edward Island and Quebec to North Carolina and Tennessee, west to North Dakota and Texas.

Representatives. *Fernald & St. John 1141; M. L. Grant 3238; Heller 1002; Lindheimer 615.*

6. **Cicuta Victorinii** Fern. Rhodora 41: 441, pl. 561, figs. 1–2. 1939.

Type locality. Tidal flats of the St. Lawrence River, Quebec: "greves intercotidales, Cap Rouge pres du Pont de Quebec, 9 aout 1922," *Victorin 15,479.*

Distribution. Known only from the estuary of the St. Lawrence River, Quebec.

Representatives. *Fernald & Long 24,249; Victorin 15,480.*

7. Cicuta bulbifera L. Sp. Pl. 1: 255. 1753. *Cicutaria bulbifera* Lam. Encycl. 2: 3. 1786. *Keraskomion bulbiferum* Raf. New. Fl. 4: 21. 1836.

Type locality. Virginia, Canada, *Clayton.*

Distribution. Newfoundland and Quebec to Delaware and Pennsylvania, west to British Columbia and Oregon.

Representatives. *Cusick 2966; Heller & Heller 551; Sandberg, MacDougal & Heller 789.*

Department of Botany,
University of California, Berkeley,
May, 1941.

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3. ————. Contr. U. S. Nat. Herb. 7: 93–100. 1900.
4. Greene, E. L. Pittonia 1: 271–272. 1889.
5. ————. Pittonia 2: 1–11. 1889.

## GREAT BASIN PLANTS—VI. NOTES ON GENTIANA

Bassett Maguire

Continuing the series of minor papers discussing plants of the Great Basin, these notes are concerned with the delineation of a newly recognized geographical population of *Gentiana calycosa,* and the confirmation of a range extension of *G. barbellata.* All specimens herein cited are on deposit at the Intermountain Herbarium. The United States Forest Herbarium, Washington, D. C., is designated by the symbol USFH.

Gentiana barbellata Engelm. The following collection confirms the queried inclusion of the species within the Utah range by Tidestrom. Utah. Sanpete County: frequent, stony, steep, west-facing slopes, summit of Horse Shoe Mountain, South Peak, 12,000 feet, Manti National Forest, August 11, 1940, *Maguire 20059.*

Gentiana calycosa Griseb. subsp. **typica** nom. nov., *G. calycosa* Griseb. in Hook. Fl. Bor. Amer. 2: 58. 1838. *Dasystephana obtusiloba* Rydb., Bull. Torr. Bot. Club 40: 464. 1913. *D. monticola* Rydb. *l.c.*

Gentiana calycosa Griseb. subsp. **asepala** subsp. nov. Herbae perennes parvulae; caulibus decumbentibus, 5–10(12) cm. longis; foliis ovatis vel ovato-ellipticalibus 1.0–1.5(1.7) cm. longis; floribus solitariis; corollis 3–4 cm. longis; calicibus membranaceis, graviter incisis, lobis obsoletis vel inconspicuis subulatisque, rare excedentibus 1–1.5 mm.

Low perennial herbs; stems decumbent, 5–10(12) cm. long; leaves ovate to ovate elliptical 1.0–1.5(1.7) cm. long; flowers solitary, corolla 3–4 cm. long; calyx membranaceous, characteristically deeply incised on two sides, lobes obsolete, or inconspicuous and subulate, rarely more than 1–1.5 mm. long.

Type. Meadows about seepage areas, southeast slopes, saddle west of Mount Agassiz, 11,500 feet elevation, Uinta Mountains, Duchesne County, Utah, August 15, 1933, *B. Maguire, Ruth Maguire, & A. G. Richards, 4225.*

Specimens examined. Idaho. Custer County: meadow, Steward Canyon, 8000 feet, Lemhi National Forest, July 17, 1931, *S. L. Jacobs 90* (USFH, 65577). Idaho County: Floyd Meadow, 6000 feet, Idaho National Forest, August 8, 1930, *C. Gray CG57* (USFH, 67318). Lemhi County: Allen Lake Meadow, 8000 feet, Salmon National Forest, September, 1930, *A. H. Wheeler 70* (USFH, 84421). Valley County: Nameless Meadow, 6500 feet, Fayette National Forest, September 1, 1930, L. N. Wellman 18 (USFH, 67628) mixed with *G. affinis.* Blaine County: alpine slopes, base Devil's Bedstead, Sawtooth Range, 8000 feet, July 28, 1936, *J. W. Thompson 13549.* Custer County: damp, springy soil, Toxaway Lake, 10 miles west-southwest of Obsidian, Sawtooth Mountains, 8500 feet, August 8–11, 1937, *C. L. Hitchcock & J. S. Martin 5749;* Mount Hyndman, August 11, 1939, *Ray J. Davis 1704.* Nevada. Elko County: meadow, Ruby Ranger Station, 6000 feet, Humboldt National Forest, June 28, 1930, *L. E. McKenzie 28* (USFH, 64353). Utah. Summit County: meadows, Lily Lake, 10,500 feet, 3 miles west of Bald Mountain, Uinta Mountains, August 14, 1933, *Maguire et al. 4224;* bogs, west shore Henry's Fork Lake, 10,850 feet, Uinta Mountains, August 4, 1936, *Maguire et al. 14381.* Uintah County: wet place under spruce, south base of Liedy Peak, 10,000 feet, Uinta Mountains, August 21, 1939, *Maguire 17678.* Specimens from Oregon intermediate to subsp. *typica* are: Baker County: Antony Lakes Region, Blue Mountains, 7100 feet, July 23, 1936, *J. W. Thompson 13430.* Wallowa County: meadows, Mirror Lake, Eagle Cap Peak, Wallowa Mountains, 7500 feet, September 24, 1938, *C. W. Sharsmith 3971.*

The subspecies of *Gentiana calycosa* may be distinguished as follows:

| Subspecies *asepala* | Subspecies *typica* |
|---|---|
| Stems conspicuously decumbent, 5–10 (12) cm. long. | Stems erect, or slightly decumbent at the base, (8)10–20 cm. long. |
| Leaves 1.0–1.5(1.7) cm. long. | Leaves (1.5)2.0–3.0 cm. long |
| Corollas 3–4 cm. long. | Corollas 3.5–4.5(5.0) cm. long. |
| Calyx membranaceous, deeply incised, lobes obsolete, or inconspicuous and mostly subulate, 1.0–1.5(2.0) cm. long. | Calyx membranaceous mainly in the sinuses, not at all or rarely incised, lobes foliaceous, ovate, elliptic, or lanceolate, 5–10(15) mm. long. |
| A Great Basin-Intermountain race, apparently confined to Utah, Nevada and Idaho. Intermediate plants are known from eastern Oregon. | The population of the Rocky Mountains and the Sierra Nevada, extending into Alberta and British Columbia. |

The smaller, frequently almost procumbent subspecies is primarily and sharply set off from the typical population by the critical calyx distinction. It further occupies a clear-cut southern geographical range. Interestingly there is considerable similarity in its calyx characters to those of *Gentiana Parryi* of the southern Rocky Mountains, suggesting that this latter species might be likewise a southern, but more complete segregate of *G. calycosa* subsp. *typica*.

Intermountain Herbarium,
Utah State Agricultural College, Logan.
May 11, 1941

# ARNICA IN ALASKA AND YUKON

## BASSETT MAGUIRE

For some time the manuscript of a monograph of the genus *Arnica* has been completed, and is awaiting publication. During the course of the work the writer had been asked by Dr. Eric Hultén to contribute the account of *Arnica* for the "Flora of Alaska and Yukon," now appearing in parts. Because of the immediacy of the needs of Dr. Hultén, and because appearance of the "monograph" does not, in the near future, seem probable, the following new entities, new names, and new combinations, for the most part, are herewith extracted from that study. Only the principal synonomy is given for the new names and combinations. Sequences and numbering of entities is that employed in the treatment prepared for Hultén's "Flora."

1a. ARNICA ALPINA (L.) Olin subsp. **angustifolia** (Vahl) comb. nov. *A. angustifolia* Vahl, Fl. Dan. 3. 1816; *A. alpina* (L.) Olin var. *angustifolia* Fernald, Rhodora 36: 96. 1934.

1b. ARNICA ALPINA (L.) Olin subsp. **attenuata** (Greene) comb. nov. *A. attenuata* Greene, Pittonia 4: 170. 1900.

1c. ARNICA ALPINA (L.) Olin subsp. **tomentosa** (Macoun) comb. nov. *A. tomentosa* Macoun, Ottawa Nat. 13: 168. 1899; *A. tomentosa* Greene, Pittonia 4: 168. 1900; *A. pulchella* Fernald, Rhodora 27: 18. 1915.

2a. ARNICA LOUISEANA Farr subsp. **frigida** (Meyer) comb. nov. *A. frigida* Meyer ex Ilijin, Trav. Musc. Bot. Acad. Sc. U.S.S.R. 19: 112. 1926; *A. nutans* Rydb. N. Am. Fl. 34: 328. 1927; *A. Sancti-Laurenti* Rydb., N. Am. Fl. 34: 328. 1927.

a. Var. **genuina** nom. nov. *A. frigida* Meyer ex Ilijin *l.c.*

b. Var. **Mendenhallii** (Rydb.) comb. nov. *A. Mendenhalli* Rydb. N. Am. Fl. 34: 329. 1927.

c. Var. **brevifolia** (Rydb.) comb. nov. *A. brevifolia* Rydb. N. Am. Fl. 34: 329. 1927.

d. Var. **illiamnae** (Rydb.) comb. nov. *A. Illiamnae* Rydb. N. Am. Fl. 34: 331. 1927.

e. Var. **pilosa** var. nov. Caulibus 5–10 (15) cm. altis, foliis 2.0–4.0 (5.0) cm. longis, denticulatis; herbaceo exigue piloso; pedunculis dense pilosis; pericliniis densus subflavis lanato-pilosis; capitulis nutantibus, aut plus frequenter erectis; acheniis glabratis, aut plus frequenter sparse super hirsutis.

Type. Igloo Creek, McKinley National Park, July 11, 1932, *Joseph Dixon 29*. Deposited in the Herbarium of the University of California; isotype at the United States National Herbarium.

This population, seemingly confined to the Mount McKinley area, is strongly marked. Plants with erect heads closely resemble specimens of *A. alpina* subsp. *tomentosa,* to which indeed they had mostly been referred. The basally or entirely glabrous achenes, and the yellowish periclinial pubescence seem, however, definitely to relate the McKinley plants to *A. louiseana.*

4a. ARNICA CORDIFOLIA Hook. subsp. **genuina** nom. nov. *A. cordifolia* Hook., Fl. Bor. Am. 1: 33. 1834.

a. Var. **pumila** (Rydb.) comb. nov. *A. pumila* Rydb. Mem. N. Y. Bot. Gard. 1: 433. 1900.

5a. ARNICA CHAMISSONIS Less. subsp. **genuina** nom. nov. *A. Chamissonis* Less., Linnaea 6: 238. 1831.

a. Var. TYPICA Regel, Suppl. Ind. Sachal 151. 1864.

b. Var. **interior** var. nov. Foliis inferioribus plus petiolatis, 2.5–3.5 cm. latis; capitulis 15–18 mm. latis; corollis disci 7–8 (10) mm. longis.

Type. Palliser, July 30, 1906, *S. Brown 770*. Type deposited in the Gray Herbarium; isotypes at United States National Herbarium, New York Botanical Garden, Academy of Natural Sciences, Philadelphia, Missouri Botanical Garden.

The variety *interior* is the common inland form, and by far the greatest population, extending southward into Canada. It differs from, although completely intergrading with, the maritime var. *typica* Regel in having mostly petiolate rather than sessile lower cauline leaves, smaller heads (18–20 cm. broad in var. *typica*), and shorter disc flowers (9–11 mm. long in var. *typica*).

6a. ARNICA AMPLEXIFOLIA Rydb. subsp. **genuina** nom. nov. *A. amplexifolia* Rydb. Mem. N. Y. Bot. Gard. 1: 434. 1900; *A. amplexicaulis* Nutt. Trans. Am. Phil. Soc. n.s. 7: 408. 1841, non Wall. 1837.

a. Var. **borealis** (Rydb.) comb. nov. *A. borealis* Rydb. N. Am. Fl. 34: 351. 1927.

6b. ARNICA AMPLEXIFOLIA Rydb. subsp. **prima** subsp. nov. Rhizomate longo, 2–3 mm. diametro, sparse radicellis vestito; caule 4.0–7.5 dm. alto, simplici, gracili, non furcato; foliis caulinis 5–7 jugis, elliptico-lanceolatis remote serrato-dentatis, 2–3 cm. latis, 6–8 cm. longis, capitulis 1–3, hemispherico-campanulatis, 12–15 mm. altis, pericliniis moderatis pilosis, longi stipitato-glandulosis.

Type. Kodiak, August 28, 1867, *A. Kellogg 231.* Deposited at the Academy of Natural Sciences, Philadelphia; isotypes at Gray Herbarium, United States National Herbarium, Missouri Botanical Garden, and a specimen of questionable authenticity at the New York Botanical Garden. The subspecies occurs only in maritime Alaska and on the Alaskan islands.

This subspecies may be separated from subsp. *genuina* by the following key:

| | |
|---|---|
| Cauline leaves 5–7 pairs, the lower 2 or 3 pairs petioled, margins only inconspicuously dentate-serrate; mostly with 1–3 heads; plants of the Alaskan Coast region and islands ... | *A. amplexifolia* subsp. *prima* |
| Cauline leaves 5–12 pairs, mostly all sessile, margins mostly conspicuously sharply serrate-dentate; mostly with 5(3)–7(9) heads; occurring from Alaska to California and Montana ... | *A. amplexifolia* subsp. *genuina* |

This clearly distinct race is interesting and important. It shows much similarity to *Arnica Chamissonis* and *A. amplexifolia* subsp. *genuina,* in leaf character and pubescence, and particularly resembles the former in the tendency to produce long unappendaged rhizomes. Indeed the intermediate characters of this rather small group of plants strongly suggest the possible derivation of the remainder of the subgenus *Chamissonis* through *A. Chamissonis.* Or, again, this entity of primarily insular distribution might prove to be hybrid between *A. amplexifolia* and *A. Chamissonis.*

8a. Arnica Lessingii Greene subsp. **genuina** nom. nov. *A. Lessingii* Greene, Pittonia 4: 167. 1900.

8b. Arnica Lessingii Greene subsp. **Norbergii** Hultén and Maguire. Caulibus 2.5–3.5 dm. altis, foliis caulinis 5–6 jugis, (3) 5–8 cm. longis, 1–1.5 cm. latis, ellipticis, acutis, herbacio sparse aut moderate moniliformo-pilosis.

Type. Orca, August 14, 1937, *I. L. Norberg.* Deposited at Lund; isotype at Utah State College.

So striking and distinctive are the type specimens in height and in the numerous pairs of narrower cauline leaves (3–4 pairs in subsp. *genuina*) that the authors venture to designate them as a subspecies. Were it not for approaching intermediates (*Hultén 8144* from Juneau) they should be tempted to propose these plants as representing a separate species. A somewhat similar plant, *Anderson 2A 375* from Mendenhall, is questionably referred here. It may be found that the Norberg specimens represent sole disparities and hence are best relegated to varietal rank.

Intermountain Herbarium,
Utah State Agricultural College,
Logan, Utah.

# A COMPARISON OF THE EMBRYOGENY OF PICEA AND ABIES

J. T. Buchholz

Picea Smithiana Boiss. The embryogeny of *Picea Smithiana* Boiss. was observed in the spring of 1936 in trees planted on the campus of Stanford University. Though it was impossible to follow the entire embryogeny, the stages of suspensor formation were observed in considerable detail and this account will serve to present more fully than heretofore the differences between the suspensor of a spruce and that of a fir, which will also be described in greater detail.

*Picea Smithiana* is a species introduced into cultivation more than a century ago from southern Asia. Its native region is given as Afganistan and the Himalayas. Its embryogeny appears to be very similar to that of *Picea Abies* (L.) Karst., (*P. excelsa*), and several American spruces which the writer has examined previously and is probably typical for the genus *Picea.*

The development of the proembryo was not observed. Miyake (7) gave us a description of the proembryo of *Picea excelsa* in all stages. Another record in the form of drawings made nearly a century ago by Schacht (8) describing the late stages in the proembryo of *Picea glauca* (Moench) Voss has been generally overlooked because it was given under the name *Abies alba* Michx., a synonym of *Picea glauca.*

Four tiers of four cells each are found in the proembryo. *Pinus* and nearly all genera of Pinaceae (Abietineae) have this same type of proembryo (2, 4). The uppermost tier of cells is incompletely surrounded by walls, and these four nuclei soon disappear. The uppermost tier of walled cells is the rosette, the name given to this structure by Schacht. Below this is a tier of suspensor cells which elongate in unison, and push the embryonic tier forward into the female gametophyte. The embryonic tier divides very soon after the elongation of the suspensor has begun.

This precocious division of the embryonic cell to form an additional tier is a feature wherein the spruce differs from the fir. In *Abies* the tier of embryonic cells may remain undivided for a considerable period, during which the suspensor becomes very long.

Figure 1 shows the earliest stage of the embryo of *P. Smithiana* obtained from dissections. The division of the embryonic cells into two tiers has already taken place, although the cells of the suspensor tier have only become elongated in the ratio of about 6 : 1. Figure 2 shows a later stage in which the four lowest cells have divided again, so that three cells are now replacing each of

Explanation of the Figures. Plate 15.

Plate 15. Successive Stages in Embryogeny of Picea Smithiana. Figs. 1–6, × 60 (fig. 2 an optical section). $s$ = primary suspensor, $e$ = tier of embryonic cells; $e_1$, $e_2$, $e_3$ = successive tiers of embryonal tubes that constitute secondary additions to the suspensor system.

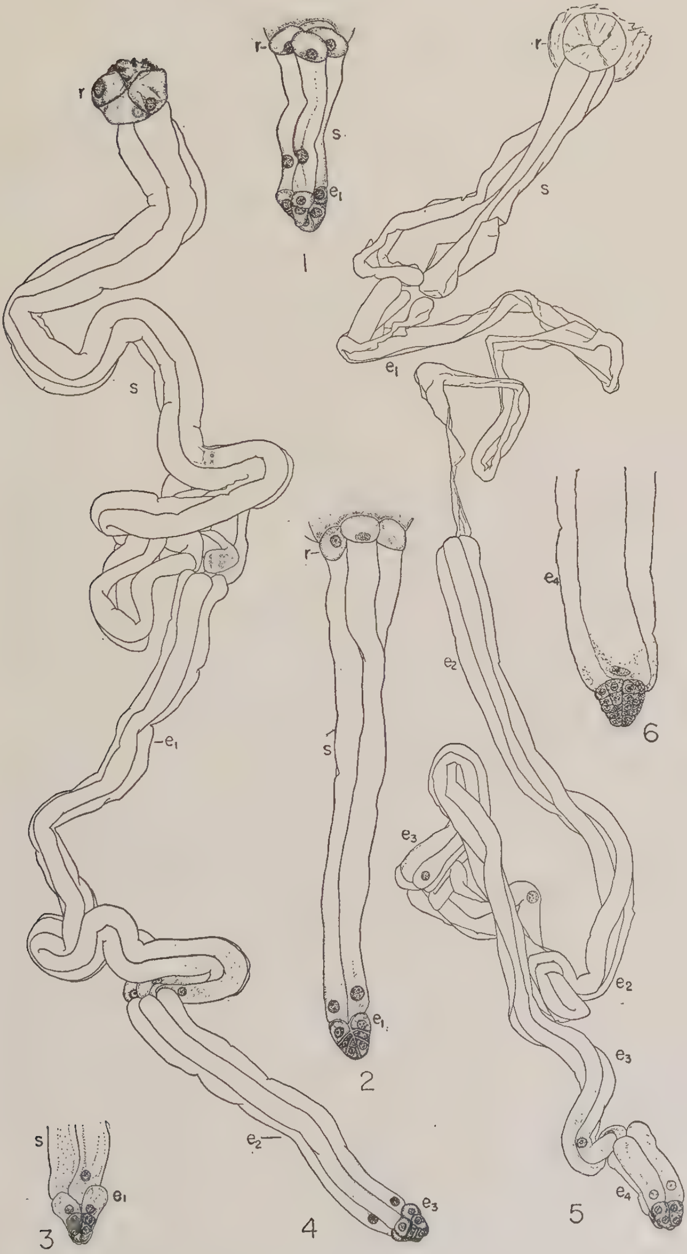

Plate 15. Successive Stages in Embryogeny of Picea Smithiana.

the four original embryonic cells as found in the lowest tier of the proembryo. In figure 3, the tier of cells next to the suspensor is beginning to elongate. This elongation is succeeded by that of the next tier, and by that of adjacent cells in tiers still to be added by the division of the terminal tier. Figure 4 shows a suspensor system in which the *s*, $e_1$ and $e_2$ tiers have elongated. For convenience the first tier is called the primary suspensor tier and the series of cells that elongate in successive 4-celled tiers may be designated as embryonal tubes $e_1$, $e_2$, $e_3$, and $e_4$. The $e_4$ is the last tier to be added to this regular succession before the terminal group of embryonic cells becomes more actively meristematic to increase greatly the number of cells in the entire embryo. The tiers that elongate subsequently to add the secondary suspensor come off in more irregular groups of cells. Figure 5 shows this stage in an embryo which has produced the $e_4$ sections of the suspensor. It is likely that the $e_3$ tier may at times be the last regular tier and in subsequent stages, the embryonal tubes lose their symmetry, become interlocked and more irregular in their elongation as they build up a massive secondary suspensor.

The writer can find no essential difference in appearance between the tiers *s*, $e_1$, $e_2$, $e_3$, etc., in *Picea.* There is probably no valid reason for making the distinctions implied by the names primary suspensor *s* and embryonal tubes of the successive orders $e_1$, $e_2$, etc., but this somewhat arbitrary designation is retained for the sake of uniformity and because it does seem to make a difference when compared with other genera of conifers. Figure 6 shows an embryo of more than 30 cells in which about 8 cells are adjacent to $e_4$ tier, which will elongate to form a much more massive addition to the suspensor.

The early suspensor system is, therefore, segmented and made up of four or five 4-celled and regularly tiered tubes. *Picea* has a rosette in which nuclei remain visible for some time, but the nuclei in the rosette disappear without undergoing division about the time the nuclei of the primary suspensor cells disintegrate. The successive suspensor cells collapse in the order of their age so that their remains and those of the rosette are sometimes difficult to find. The cells in the successive suspensor segments become about 20 to 30 times as long as their original diameter before the nuclei disappear and the suspensor elements collapse.

In *Picea,* simple polyembryony prevails. The fertilization of several eggs may give rise to several embryos which compete with each other, but the product of a single fertilized egg does not split up into several embryos, as in *Pinus, Cedrus* and *Tsuga.* The single embryo which survives usually has 8 to 10 cotyledons.

PICEA OMORIKA (Pancic) Purkyne. The Siberian spruce was examined a number of years ago from trees planted at the Arnold Arboretum. The stages obtained were somewhat older than those described above, but the succession of tiered suspensor elements could also be observed in this species. Since the oldest elements had collapsed, it was not possible to be certain that $e_4$ was the last 4-celled tier that had elongated, though an $e_3$ tier could be recognized. In respect to the suspensor system and simple polyembryony, this Siberian spruce agrees with other spruces. The embryo as found in the mature seed of *Picea Omorika* had 5 to 6 cotyledons.

ABIES VENUSTA (Dougl.) K. Koch. The material for a study of the embryogeny of the Santa Lucia fir came from trees planted on the campus of Stanford University. The trees in the Santa Lucia mountains, their native region, were found to be too inaccessible and too far removed from a laboratory. Those on the grounds of Stanford University could be studied within an hour after collection. Their advantages were the early fertilization and the fact that the schedule of development fitted more conveniently into a research program which included other conifers.

The proembryo of no species of *Abies* has been adequately investigated. Miyake (6) observed only the free nuclear stages and Hutchinson (5) added a few stages in a study of *Abies balsama*. Hutchinson's account, especially his statement: "the proembryo of *Abies* ordinarily consists of eight cells only, in two tiers" is misleading and might leave one with the impression that *Abies* has a program in its proembryo which differs from other conifers. Actually it is very similar to *Pinus* (4) and *Picea* (7) in its early stages.

There is no doubt that the proembryo is the same as that described above for *Picea* except that the embryonic tier does not divide immediately. This tier divides only after considerable elongation of the suspensor tier.

The three tiers of cells—rosette, suspensor, and embryonic—are still present and undivided in *A. venusta* when the suspensor has elongated considerably. This is shown in figure 7 and in figure 8. Thus it is clear that there is really no serious hiatus in our knowledge concerning the proembryo of *Abies*. An opaque deposit has appeared over the rosette and all traces of the tier of relict nuclei have disappeared. In figure 9 each cell of the lowest tier of embryonic cells has divided so that this quartette of cells has now formed an octette arranged in two tiers. In figure 10 each of the original quartette of cells is represented by a progeny of four cells. The details of the embryo in figure 10 are shown better under higher magnification in two planes of focus in figures 10a and 10b.

The pointed tip of the embryo has a very thick hyaline wall which is also shown best in figures 10a and 10b. The pointed ends are very close together at first (figs. 7–9), become separated with the growth and lateral enlargement of the embryo, and remain as tiny projecting knobs that serve to identify the four derivative cell groups. These hyaline tips may be seen in successive stages shown by figures 11, 16, 17, and are obscurely recognizable in figure 18, in which the embryo has several hundred cells.

Sometimes the vertical rows do not contribute equally to the embryonic mass. Figures 12 and 13 show conditions in which inequalities have appeared in the development of the progenies of the 4 original embryonic cells. These do not show the small knobs that are seen in figure 17. In the latter, and in figure 18, the evidence is fairly conclusive that the cell progenies of the four original embryonic cells have contributed equally to the embryonic tissue.

Simple polyembryony prevails in *A. venusta* and is the normal condition in all firs that have thus far been examined. The product of each fertilized egg gives rise to a single embryo below the suspensor, and whether the four terminal embryonic cells contribute equally, as indicated in figures 17 and 18, or unequally, as indicated in figures 12 and 13, appears to make no distinguishable difference in later stages.

The suspensor *s*, composed of four cells, is remarkable in the amount of its elongation. Each cell elongates to about 60 times its original diameter before the terminal embryonic cells undergo their first division, and eventually becomes 150 to 200 times this length before the secondary suspensor begins to elongate, and before the primary suspensor cells collapse. Figure 16 has a suspensor in which each cell is fully 200 times as long as the width of these cells in figures 7 and 8. Figure 17 has suspensor cells that are not quite as long, but the ratio is fully 160 : 1. The latter has probably ceased elongation for the nuclei are no longer visible.

The secondary suspensor is formed by the elongation of cells (usually spoken of as embryonal tubes), from the distal end of the embryo, as shown in successive stages by figures 12, 13 (pl. 16) and 16–20 (pl. 17). As the enlarging embryo becomes wider, the number of elongating cells increases (figs. 13, 18), so that the secondary suspensor now becomes increasingly more massive. The suspensor system may become greatly coiled and twisted. In dissections, some of these twists were removed, and those that are shown in the figures are not necessarily the ones that were most extreme before dissection. The newest additions of the secondary suspensor elongate most rapidly. These projecting newly-

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EXPLANATION OF THE FIGURES. PLATE 16.

PLATE 16. STAGES IN EMBRYOGENY OF ABIES VENUSTA. Figs. 7–8, earliest stages dissected show 12 cells of 16-celled proembryo still undivided. Fig. 9, lowest (embryonic) tier of cells has divided. Fig. 10, later stage after four embryonic cells have each become 4-celled, with details of embryo shown in surface view in 10a and in lower focus in 10b (× 147). Fig. 11, later stage with 8 cells in each of the four embryonic cells. Fig. 12, formation of secondary suspensor by elongation of cells from distal end of embryo. Fig. 13, later stage of same, showing rosette embryos derived from rosette cells, and well developed secondary suspensor with the suspensor cells now irregularly interlocked. Figs. 14–15, rosette embryos from embryo systems of stage similar to Figs. 12–13. All figures, except 10a and 10b, × 60. *r* = tier of rosette cells; *s* = primary suspensor; *e* = tier of embryonic cells.

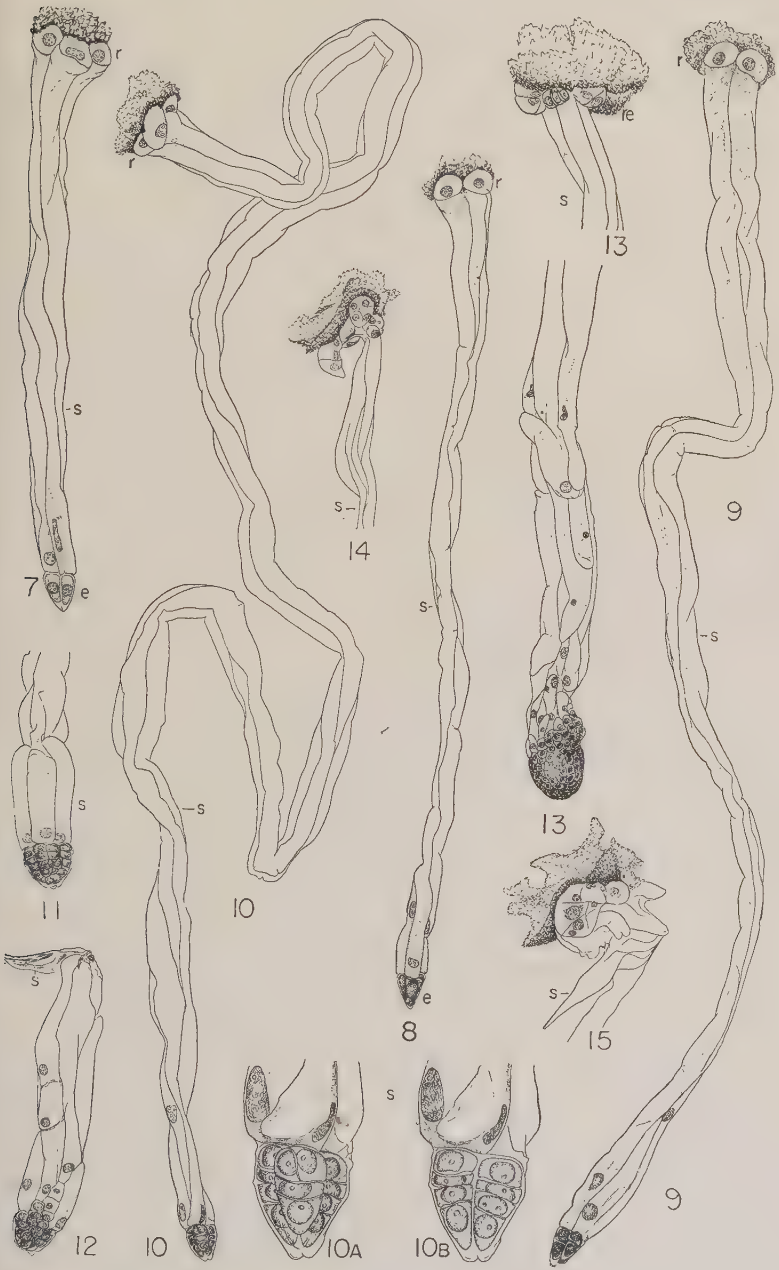

Plate 16. Stages in Embryogeny of Abies venusta.

formed embryonal tubes usually ensnare any shorter embryos from another zygote that may be situated behind them and push the shorter rivals back toward the region of the archegonia.

*Abies venusta* usually forms rosette cells. A majority of these form rosette embryos, as may be seen in the upper part of figure 13 and in figures 14 and 15. These secondary embryos are formed only after considerable delay, during which the primary suspensor becomes fully elongated. In early stages shown by figures 7 to 10, and even in figure 16, the rosette cells usually remain undivided. In figure 17, each of the two rosette cells has divided once. Figures 14 and 15 were taken from embryos that had not only fully-elongated and collapsed primary suspensors, but the embryos had become massive and had developed secondary suspensors similar to those shown in figures 18 and 19. It was also observed that sometimes these rosette cells may fail to divide; the nuclei may disintegrate and the cells collapse without forming embryos.

The later stages of the successful embryos are shown in figures 19 and 20. *Abies venusta* agrees with other members of this family of conifers in that the primordium of the stem tip appears as a slight protuberance before the cotyledonary primordia are formed.

The embryo shown in figure 20 had 7 cotyledons surrounding and obscuring the primordium of the stem tip. The cotyledon number varied between 5 and 8. In a count of about 150 embryos, the mean number of cotyledons was 6.5.

The embryo of figure 20 has a conspicuous calyptroperiblem. This structure, which replaces the root cap in conifers, merges with the secondary suspensor and surrounds the plerome of the root tip. A ridge surrounding the embryo of figure 20 just below the middle marks the outer margin of the calyptroperiblem. In respect to this feature, the embryo of *A. venusta* resembles that of *Cedrus* (3) more than that of *Picea.*

ABIES PINSAPO Boiss. Embryological material of the Spanish fir was obtained from reproductive specimens found on the Mills Estate at Millbrae and on the Flood estate near Menlo Park, both in California. Only the early stages in the embryogeny were satisfactory. In stages later than those shown in the accompanying figures (21–24), the embryos were all aborted and the entire gametophytes shriveled up so that no viable seeds were matured. In the early stages there was a remarkable similarity with the embryogeny of *A. venusta.*

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EXPLANATION OF THE FIGURES. PLATE 17.

PLATE 17. LATER STAGES IN EMBRYOGENY OF ABIES VENUSTA. Figs. 16–17, embryo systems showing extreme length of suspensor in a stage subsequent to Fig. 10, ×60. Fig. 18, embryo on well-developed secondary suspensor (stage following Figs. 11–13), ×60. Fig. 19, stage showing primordium of stem tip, ×20. Fig. 20, embryo after cotyledonary primordia have formed, ×20. $r$ = rosette cells; $s$ = primary suspensor; $e_1$ = beginning of secondary suspensor.

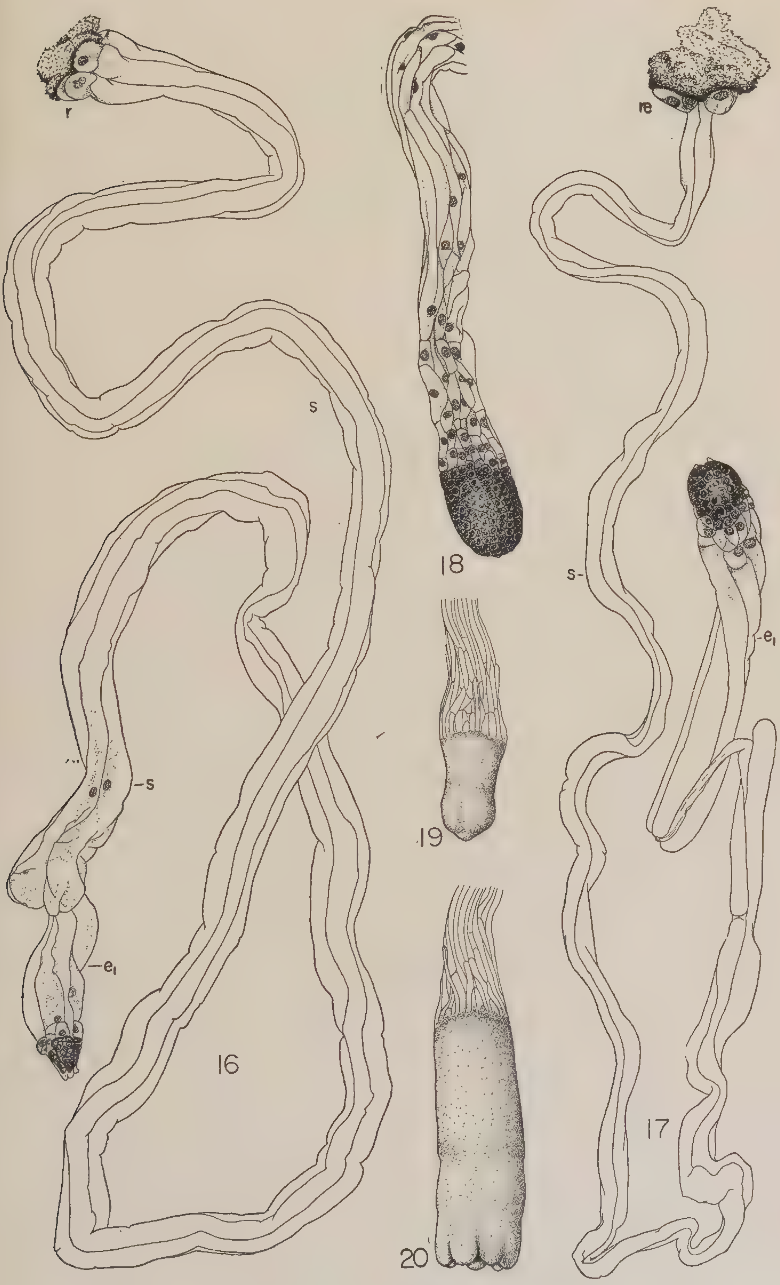

PLATE 17. LATER STAGES IN EMBRYOGENY OF ABIES VENUSTA.

## Discussion

In the writer's earliest investigations on polyembryony (1), where the similarity in *Abies* and *Picea* with respect to simple polyembryony was stressed, the differences in the suspensor systems of these two genera was entirely overlooked. Unfortunately, these diagrams (copied by several authors) have been taken too literally. Much greater accuracy was achieved in a later publication (2), but in the second set of drawings, the rosette cells had usually collapsed in the embryos with long suspensors—those that were selected for the illustrations.

In re-examining these preparations, it is obvious that the single tier of primary suspensor cells of *Abies balsamea* collapses earlier and does not become as extreme in its elongation as the same structure in *A. venusta*. The difference between the spruce and fir is apparent in these old preparations and in the drawings made in 1930, which are fairly accurate, but the rosette cells and the older parts of the suspensor elements are so shriveled that they are very difficult to recognize.

Another feature which makes the rosettes and suspensor structures very difficult to study is not only the deposit shown above the rosette in nearly all of the figures, but a similar gummy or resinous deposit which surrounds the upper region of the suspensor system, omitted in all of the drawings.

There were several objectives that motivated this investigation. It was suspected that the embryogeny might offer features which would serve to separate *A. venusta* from the remaining firs and place it, either in one of the other genera or in a new genus. It was also desirable to discover the basis for a clearer definition of the differences between the genera *Picea* and *Abies*, both of which have simple polyembryony.

The taxonomic differences between *Abies venusta* and other firs are very marked. There are differences in the leaves, winter buds, bracts of the cone scale, and in the fact that the branches of this species are somewhat flexible and do not hold the cones erect as in other firs. The seed cones are inserted at nearly right angles on the twigs that bear them, are erect in early stages, but later their weight bends the slender twigs downward, so that many cones appear to be borne in horizontal positions, sometimes even drooping downward. The external differences may not be of great importance, but some of these characters such as the large peculiar winter buds and the very long, pointed leaves, so different from other firs, may have caused botanists to wonder whether this species may not represent something other than a true fir. In fact, several botanists, in discussing the unique external features in the Santa Lucia fir expressed the wish that the embryogeny be investigated in the hope that this might contribute new facts that might possibly prove to be decisive. *Abies Pinsapo* offered many external taxonomic features of contrast with *A. venusta*. How-

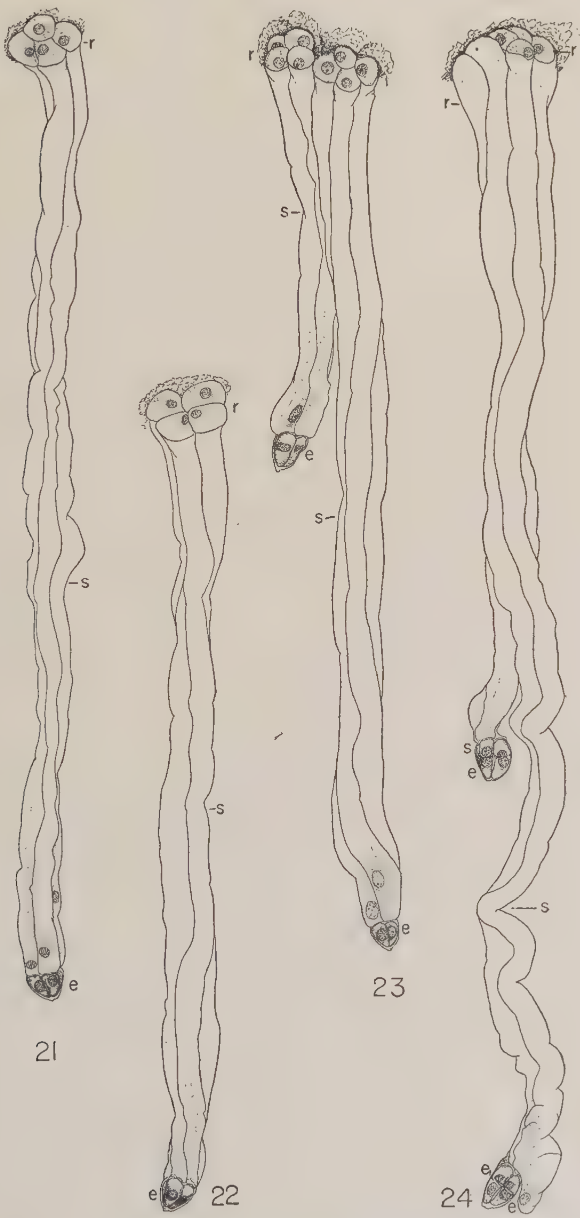

Plate 18. Successive Stages in Embryogeny of Abies Pinsapo. The paired embryo systems, Figs. 23–24, were dissected from the same ovules, × 60. *s* = primary suspensor; *e* = tier of embryonic cells.

ever, the embryogenies of these two species are in close agreement in the early stages that were observed.

*Picea* and *Abies* have a similar type of proembryo and both have simple polyembryony. Even though the proembryo of *Abies* has not been fully investigated, the three tiers of cells that remain are still undivided in the earliest stage shown in figure 7. The two genera differ, however, in the manner in which the suspensor system develops. In *Picea,* the primary suspensor tier (*s*) is followed by a succession of three or four similar additions, $e_1$, $e_2$, $e_3$, and $e_4$ before the secondary suspensor becomes irregular and may consist of many cells; in *Abies* a very long primary suspensor is formed which is directly succeeded by a more irregular many-celled secondary suspensor.

In *Picea,* rosette cells are formed but they usually abort and have not been observed to develop into embryos. In *Abies balsamea* and *A. Pinsapo,* these rosette cells usually fail to develop as in *Picea,* but in *A. venusta* a considerable number of instances were observed in which rosette cells developed into very small embryos.

*Abies venusta* agrees on the whole with the embryogeny of other species in this genus. It differs not only from *Picea* but also from *Pseudotsuga* (1, 2), in which no rosette cells are formed. *Abies venusta* differs from *Pinus, Cedrus* and *Tsuga,* all of which have cleavage polyembryony. There is no embryological feature in *A. venusta* which would tend to segregate it from the genus *Abies* save the rosette embryos which develop in a little more than half of the embryos. Other embryological characters that are distinctive in this species are quantitative in nature. The embryology of *A. venusta,* therefore, offers little in support of the idea that this species should belong to another genus. It definitely does not belong to any of the other genera now recognized and does not show embryological features which are sufficiently unique to suggest its segregation into a new genus.

## SUMMARY

1. The early embryogeny of *Picea Smithiana* is described with special reference to the development of the suspensor system.

2. The embryogeny of *Abies venusta* is described and compared with other firs, including *A. Pinsapo,* and with *Picea.*

3. Both genera begin their development with the same type of proembryo. In *Picea* the embryonic cells divide early and form three or four additional tiers of cells that elongate successively in adding relatively short tiers of elongated sections to the suspensor system. In *Abies* the embryonic cells do not divide until the suspensor tier has become well elongated. The suspensor cells elongate as a single tier, eventually becoming as long as the 3 to 4 tiers of additions in *Picea,* or even longer.

4. Rosette cells are formed in both genera. In *Picea* and some species of *Abies* the rosette cells do not divide to form em-

bryos; in *A. venusta* the rosette cells may form embryos after the suspensor tier has become fully elongated.

5. On the whole, the embryogeny of *Abies venusta* agrees closely with other firs. It does not belong in one of the other genera of Pinaceae and there seems to be little in the embryogeny which would suggest the segregation of *A. venusta* into a distinct genus.

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July, 1941.

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## ANATOMY AND ECOLOGY OF AMMOPHILA ARENARIA LINK

EDITH A. PURER

During a period of three years, studies were made upon sand dune plants along the Pacific coast from Oregon to Baja California. Environmental factors were measured and a study of the anatomy of twelve species was undertaken. In the subsequent publication (Purer, Studies of Certain Coastal Sand Dune Plants of Southern California, Ecol. Monog. 6: 1–88, 1936) the genus *Ammophila* was omitted since it was not abundant in the particular areas where the instrumental work was carried on.

Although it is not a native species, *Ammophila arenaria* Link has been successfully planted as a sand binder in a number of areas and is fairly well distributed along the Pacific coast. Specimens were examined at the herbaria in the following institutions, Stanford University (D); University of California (UC); and the University of Southern California (USC): Linnton, Oregon, September, 1927, *Thompson 3881* (D); Eureka Peninsula, Humboldt County, June, 1899, *Dudley* (D); Point Arena, Mendocino County, August, 1899, *Davy and Blasdale 6046* (UC); one-half mile south of Lake Merced, San Francisco County, May, 1901, *Dudley* (D); Jazos Creek, San Mateo County, March, 1922, *Bacigalupi* (D);

Oceano, San Luis Obispo County, October, 1930, *de Forest* (USC); Hueneme, Ventura County, August, 1931, *Purer 2213;* strand at Spanish Bight, San Diego County, October, 1931, *Purer 2311.*

*Ammophila arenaria* thrives in open places where there is little or no vegetation, where the wind is severe, the insolation great, and the soil unstable. As a rule this grass, commonly known as sand reed, grows alone on the dunes, although occasionally plants such as *Franseria bipinnatifida* may establish themselves on sand held by *Ammophila.* Concerning the stabilization of moving dune areas, A. S. Hitchcock (Controlling Sand Dunes in the United States and Europe, Nat. Geog. Mag. 15: 46, 1904) states: "Many plants have been tried, but the most satisfactory is beach grass (*Ammophila arenaria* Link). This grass grows naturally upon the sand dunes of the North Atlantic coast of Europe as far south as Morocco, and of America as far south as North Carolina, and also along our Great Lakes. This is the grass which was used in reclaiming land which is now Golden Gate Park in San Francisco." The highway department of Oregon has also planted this species as a sand binder on dune areas of the coast.

The sand reed grows in large clumps to a height of two to three feet, the stems and the roots being produced at the nodes of elongated rhizomes. From each node of the rhizomes five or six roots, about twenty-five centimeters long and usually bearing many secondary roots two to three centimeters in length, are produced. The plant withstands partial covering by sand through the production of adventitious roots from the buried portions of its erect stems. The entire root system is smaller in proportion to the aerial parts than in other principal sand dune plants. The leaf blades which are long and gradually narrowed to a point, bend in all planes without breaking. The blades are mostly vertically placed, receiving the minimum amount of light; only old leaves are bent at an angle. Since the plant grows in tufts its leaf blades shade each other somewhat. In San Luis Obispo County the young leaves were found tightly rolled and the old leaves partially unrolled. Farther south, where the habitat is even more xeric, the leaves were always found tightly rolled; in northern California and Oregon the leaves were habitually partially unrolled. According to E. Pee-Laby (Etude anatomique de la feuille des graminées de la France. Ann. Sci. Nat. Bot. 8: 227–346, 1898) such variation is due to the relative dryness of the habitat.

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EXPLANATION OF THE FIGURES. PLATE 19.

PLATE 19. AMMOPHILA ARENARIA. *A,* stem, transverse section; *B,* vascular bundle, transverse section; *C,* folded blade, diagrammatic transverse section; *D,* blade, transverse section; *E,* infolded adaxial epidermis of blade showing motor cells; *F,* epidermal cells and stomata on adaxial surface of blade; *G,* epidermal layer of blade showing stoma, transverse section; *H,* sheath, transverse section; *I,* epidermal layer of sheath showing stoma, transverse section; *J,* root, transverse section.

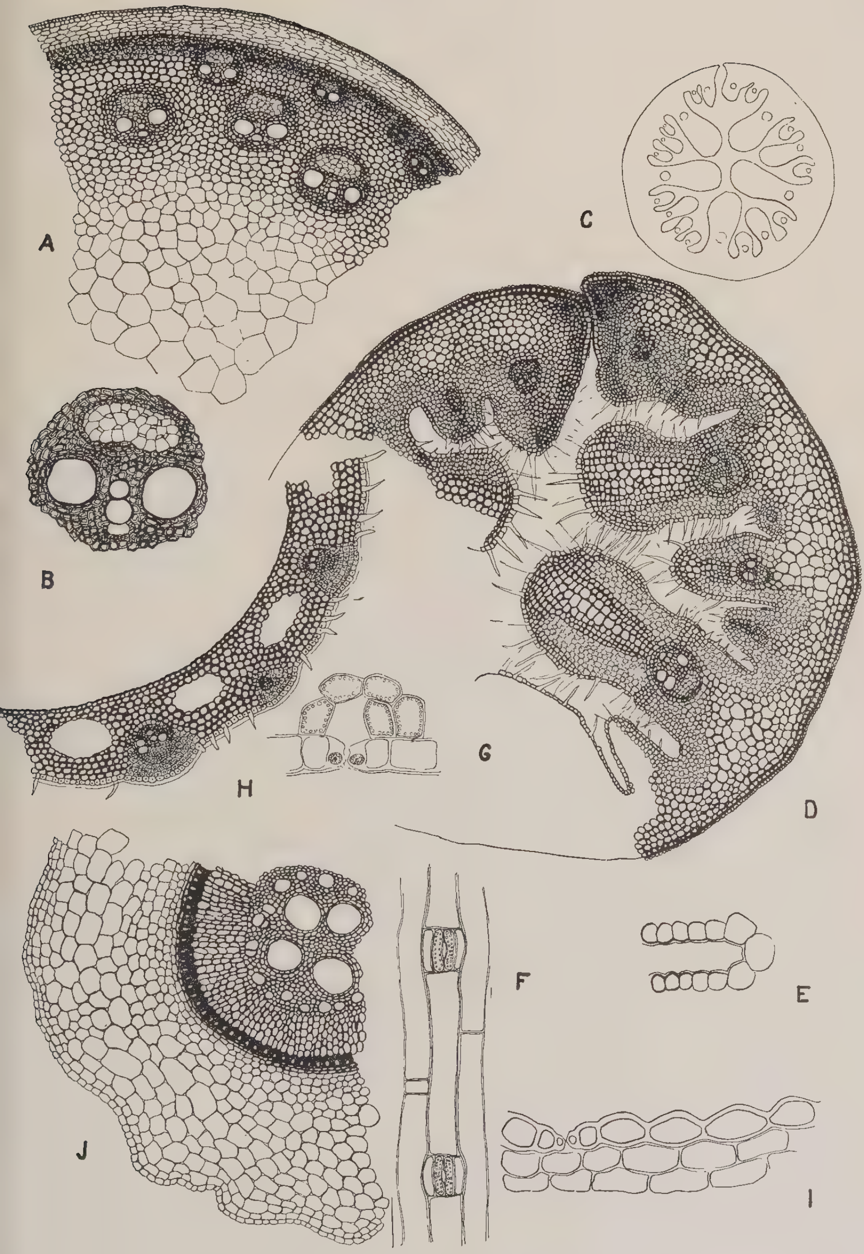

Plate 19. Ammophila arenaria Link.

The roots (pl. 19, fig. J) are short and fibrous, and when pulled from the soil easily lose their outer cortical layer. The epidermis is composed of small compactly-placed cells; inside of this is the cortex, composed of soft, closely placed parenchyma cells, which makes up about two-thirds of the root in cross-section. The endodermis is composed of very heavy-walled cells, the inner wall being especially thick while the pericycle is inconspicuous. The stele contains a few tracheae surrounded by sclerenchyma. Phloem is inconspicuous.

The stem (pl. 19, figs. A, B) is of simple monocotyledonous type, compact, with few intercellular spaces, the small epidermal cells having all their walls of about equal thickness and bearing a thin layer of cuticle. Within this tissue are about five or six rows of cortical parenchyma cells and on the inner side of these a definite ring of sclerenchyma. The scattered vascular bundles are disposed in a relatively narrow zone occupying about two-fifths of the radius, the outer bundles being embedded in the ring of sclerenchyma. The central pith is definite and conspicuous, composed of large cells occupying about three-fifths of the diameter of the young stem; old stems are usually hollow.

The outside epidermis of the sheath (pl. 19, figs. H, I) is covered with thick cuticle, and bears at frequent intervals, short, unicellular, unbranched, pointed trichomes. There is a single row of closed vascular bundles with conspicuous sheaths. Sclerenchyma surrounds these, and expands to a broad, wedge-shaped mass, causing a slight protrusion of the epidermis. In the tissue between the bundles are large lacunae running vertically through the sheath. On the inner surface in parallel rows stomata occasionally occur.

The blade and sheath portions of the leaf differ considerably in structure. The cylindrically rolled blade (pl. 19, figs. C, D) of the southern California plants is covered on the abaxial surface by a firm epidermis of small cells averaging 0.017 millimeters in their radial diameter. These bear a cuticle about 0.008 millimeters in thickness, or more than 47 per cent of the radial diameter of these cells. The outer surface of the epidermis is regularly undulate, which permits the blade to unroll without splitting the cuticle. There are no stomata in this surface. Below the epidermis are several rows of large sclerenchyma cells with moderately thick walls.

The adaxial surface of the blade, the inner face of the rolled blade, is ridged and grooved. The ridges, alternately large and small, are approximately 0.55 millimeters and 0.25 millimeters in height. The epidermis here averages 0.012 millimeters in thickness, and bears abundant unicellular, unbranched, conical trichomes with thick walls, varying in length from four to ten times the diameter of the epidermis; there is a cuticle about 0.002 millimeters in thickness, or about 17 per cent of the radial diameter of these cells. The stomata (pl. 19, figs. F, G) which are confined to the sinuses, occur in parallel rows and number about twelve per square millimeter; the stomatal pore is about 0.0014 millimeters in its long diameter, with the guard cells and the subsidiary cells measuring about 0.040 by 0.035 millimeters. The central portion of each ridge contains sclerenchyma, with a single closed fibrovascular bundle near the base of the ridge. Surrounding the grooves and extending up the sides of the ridges almost to their tops is a narrow band of chlorenchyma, which consists of small, more or less isodiametric, parenchyma cells containing numerous chloroplasts. The top of each ridge is completely filled with sclerenchyma to the point where the chlorenchyma begins. Groups of motor cells (pl. 19, fig. E) are found at the bottom of each of the grooves; the intercellular spaces are small and few. The ridged and grooved surface of the involute blade results in a withdrawal of the chlorenchyma from the light. Transpiration in the leaf is checked by inrolling, by the heavy cutinization of the abaxial surface, and by the infrequent stomata which occur only in the grooves of the inrolled epidermis where they are overlapped by the trichomes.

San Diego, California,
February 4, 1941.

## AN UNDESCRIBED SPECIES OF CEANOTHUS FROM CALIFORNIA

Howard E. McMinn

**Ceanothus Masonii** sp. nov. *C. rigidus* variation 1 McMinn, Contrib. Dudley Herb. 1: 145. 1930, in part. *C. gloriosus* var. *exaltatus* J. T. Howell, Leafl. West. Bot. 2: 44. 1937, in part. Bolinas Ceanothus.

Frutex erectus vel erecto-patens, 6–18 dm. altus, ramis crassis arcuato-divaricatis, ramulis rigidis atro-fuscis vel purpureis, tomentulosis demum glabrescentibus; folia opposita persistentia, laminis late ellipticis vel fere orbicularibus, 6–19 mm. longis, 5–12 mm. latis, basi rotundis apice rotundis truncatisve, aliquando emarginatis, supra atroviridibus nitidis glabris, subtus albidis sub microscopio inter venas canescentibus, crebre dentatis dentibus brevibus aut rare leviter sinuato-dentatis ad basim versus integris; stipulae prominentes persistentes, 1.6–5 mm. longae; gemmae squamae fuscae glabrae vel leviter tomentulosae; inflorescentia subumbellata conglomerata, plerumque foliis binatis parvis subtentia, ramos breves (6–19 mm. longis) terminantia; flores atrocyanei vel purpurei; fructus globosus, tricornutus, 5 mm. diametro, cornibus brevibus apicalibus subapicalibusve, sine crestis intermediis instructus.

Erect or erect-spreading shrub, 6–18 dm. tall, with stout rather stiff divaricate branches and rigid dark brown or purplish tomentulose branchlets, becoming glabrous in age; leaves opposite, evergreen; the blades broadly elliptical to oval or nearly orbicular, 6–19 mm. long, 5–12 mm. broad, rounded or sometimes cuneate at base, obtuse, rounded or truncate at apex, sometimes emarginate, dark green, glabrous and glossy above, grayish white and microscopically canescent between veins beneath, margins with numerous short teeth or rarely slightly sinuate-dentate except near base; stipules prominent, persistent, 1.6–5 mm. long; bud scales brown, glabrous, or slightly tomentulose; flowers dark blue to purple, in many-flowered umbel-like clusters usually subtended by a pair of small leaves terminating short lateral branchlets 6–19 mm. long; fruit globose, about 5 mm. in diameter, with 3 short apical or subapical horns, without intermediate crests. Flowering period, March, April.

Type. Along trail on east end of Bolinas Ridge, Marin County, California, April 23, 1933, *McMinn 3044*, deposited in the University of California Herbarium, Berkeley, no. 657,550. Other representative collections: *McMinn 906, 5416, 5417;* transplant series, *McMinn 1574R, 1574O, 1574Q; Eastwood & Howell 3838.*

Bolinas Ceanothus occurs on Bolinas Ridge, Marin County, California. It is very closely related to *Ceanothus gloriosus* var. *exaltatus* J. T. Howell. These two entities belong to the *C. gloriosus-C. ramulosus-C. purpureus-C. divergens-C. confusus* complex which occurs in the North Coast Ranges of California, in Marin, Sonoma, Napa and Mendocino counties. My first acquaintance with the entity was in February, 1923, when I collected seven small plants (tentatively referring them to *C. rigidus* var. *grandifolius* Torr.) and transplanted them to the trial gardens at Mills College. On March 30, 1923, I revisited the area on Bolinas Ridge in company with Herbert L. Mason. We found vigorous mature plants associated with *Ceanothus foliosus, Arctostaphylos sensitiva, A. virgata, Quercus Wislizenii* var. *frutescens, Sphacele calycina* and *Adenostoma fasciculatum,* in an area of about two miles along the ridge. These plants occupied the drier habitats of the ridge crest.

In the late summer of 1924, a fire burned over Bolinas Ridge and destroyed most of the plants. On December 20, 1925, I again collected along the ridge. Not a single old plant of Bolinas Ceanothus was found; all had been destroyed by the fire of 1924. However, seedlings were abundant along the trail throughout the area. Twenty-three seedlings, from 4 to 12 inches tall were taken up and transplanted to the trial gardens at Mills College. At this writing, just sixteen years later, all but one (1574R) of the transplants have died. This lone survivor is about 6 feet tall and has a spread of 18 by 18 feet. The trunk at the ground is about 8 inches in diameter.

In October, 1941, Dr. Mason and I studied the species of *Ceanothus* occurring on the south slope of Mount Tamalpais and along Bolinas Ridge. *Ceanothus Masonii* was the most abundant species along Bolinas Ridge in the area which had been burned in 1924. I do not know how many times the ridge has been burned over subsequently; however, since some of the plants appeared to be at least six or seven years old, no destructive fires have occurred since 1935. Many seedlings and young plants abound in and along the ridge trail which has been cleared from time to time for use as a fire road. In addition to many plants of typical Bolinas Ceanothus, a few plants with leaves simulating those of *C. purpureus* Jepson, and a few with leaves intermediate between the two, were observed. A few plants with the large leaves and habit of growth of *C. gloriosus* var. *exaltatus* and others with smaller leaves intermediate between those of *C. ramulosus* (Greene) McMinn and *C. purpureus* were found growing along the ridge. These facts supported by additional observations made upon certain *Ceanothus* entities occurring in the North Coast Ranges, lead to the conclusion that Bolinas Ceanothus is a member of a large complex, which may consist of several species occupying different geographical and probably ecological niches.

Mills College, California,
November 27, 1941.

## NOTES AND NEWS

RANGE EXTENSIONS IN SPECIES OF WESTERN NORTH AMERICA. New localities have been reported recently for the following species:

BOYKINIA JAMESII Engelm. var. HEUCHERIFORMIS (Rydb.) Rosendahl. Growing in crevices of limestone cliffs, altitude 8800 feet, Canadian zone, above White Pine Lake, northeast slopes of Mount Magog, Cache County, Utah, July 17, 1936, *Maguire 14046*. This species is known from Colorado, Idaho and Nevada, but heretofore has not been reported from Utah.

SAXIFRAGA ERIOPHORA S. Watson. This rare plant, apparently known previously only from the type locality in the Santa Catalina Mountains, Arizona, has been collected as follows: common, moist ravine slopes along stream course in yellow pine and oak, altitude 8500 feet, Pine Crest, Pinaleno (Graham) Mountains, Graham County, Arizona, April 17, 1935, *B. & R. Maguire 10545;* altitude 8000 feet, May 26, 1936, *B. & R. Maguire 12012,* May 28, 1935, *B. & R. Maguire 12014.*—BASSETT MAGUIRE, Intermountain Herbarium, Utah State Agricultural College, Logan.

ERIODICTYON CAPITATUM Eastwood. Previously known only from Pine Canyon on Burton Mesa, five miles north of Lompoc, this species was discovered in a canyon on the James J. Hollister ranch, approximately five miles northeast of Point Conception, Santa Barbara County, California. Here, on a west-facing slope, elevation 900 feet, at the head of the west fork of Barranca

Honda, the shrub is associated with *Ceanothus cuneatus, C. papillosus, Phacelia ramosissima* var. *suffrutescens, Quercus agrifolia* and *Salvia mellifera* (July 20, 1941, *Tucker 342,* University of California Herbarium).—JOHN M. TUCKER, Department of Botany, University of California, Berkeley.

ORNAMENTAL SHRUBS AND WOODY VINES OF THE PACIFIC COAST. By Evelyn Graham and Howard E. McMinn; published October, 1941, under the auspices of Mills College, California, by the Gillick Press, Berkeley, California; price $3.00. In this volume of 259 pages the authors have presented the first general treatise on the shrubs and vines cultivated in California. The descriptions are brief and for the most part entirely non-technical, although as a convenience a comprehensive glossary of botanical terms is included. An introductory chapter presents a concise account of flowering plant organs and their functions for those who may not have had previous training in botany. Practical keys are supplied for all genera and species treated. The book is well illustrated with twenty-two plates from natural color photographs, also with 144 figures consisting of both photographs and line drawings. With this volume in hand any interested person should be able to name most of the commonly cultivated ornamental shrubs and vines of the state.—E. CRUM.

WEEDS OF CALIFORNIA. By W. W. Robbins, Margaret K. Bellue, and Walter S. Ball; published, 1941, by the State Department of Agriculture, Sacramento, California; price $2.00. This useful work, succeeding Smiley's "Weeds of California," long since out of print, is the result of years of cooperation in research and field practice between the Division of Botany, College of Agriculture, University of California, Davis, and the Division of Plant Industry, State Department of Agriculture. Descriptions, origins and distributions of 693 species of weedy plants are included; in addition the control of weeds is discussed and weeds of special crops and soils are listed. Technical terms in keys and descriptions are avoided as much as possible. The volume is well illustrated with line drawings, photographs and 24 colored plates from the work of Lena Scott Harris. Sixteen maps showing the approximate distribution of certain important species are included.—A. CARTER.

PLANT HUNTERS IN THE ANDES. By T. Harper Goodspeed; published October, 1941, by Farrar and Rinehart, Inc.; price $5.00. In this attractive volume are recounted the adventures of the members of the recent University of California Botanical Garden Expeditions to South America, especially to the Andean regions of Peru and Chile. Dr. Goodspeed, Director of the Botanical Garden and leader of the expeditions, has presented in a very readable manner material of both botanical and general interest. The book consists of 429 pages and is profusely illustrated with photographs not only of the plant life and topography of the regions visited but also of certain social aspects of the South American scene.—E. Crum.

Desert Wild Flowers. By E. C. Jaeger; second edition, published October, 1941, Stanford University Press; price $3.50. In this second edition a sixteen page popular key has been added that seems adequate when used in combination with the excellent drawings. Necessary corrections in the text have been made. The completeness of this attractive guide to the plants commends it to all who enjoy the deserts of California and their adjacent borders.—David D. Keck.

The fourteenth annual meeting of the Western Society of Naturalists was held at Stanford University, December 29 to 31, 1941. An important feature of the program was a symposium dealing with the genetic basis of evolution. The following papers were presented: "Genetic Evolutionary Processes in Crepis," Professor E. B. Babcock, University of California; "The Pattern of Relationships Revealed by Morphologic, Ecologic and Cytogenetic Evidence," Dr. Jens Clausen, Carnegie Institution of Washington Laboratory, Stanford University; "The Sterility Barrier," Dr. R. B. Goldschmidt, University of California; "Where Does Adaptation Come In?" Dr. F. B. Sumner, Scripps Institution of Oceanography, University of California. Dr. Herbert L. Mason, University of California, presided and led the subsequent discussion.

Mr. J. Francis Macbride and Dr. Francis Drouet, members of the Herbarium staff, Field Museum, Chicago, spent some time in California this fall. During part of October they collected algae, mainly in the desert regions of southern California. Mr. Macbride, however, spent nearly two months in Berkeley where he was studying the South American collections in the University of California Herbarium in connection with his work on the "Flora of Peru."

## PROCEEDINGS OF THE CALIFORNIA BOTANICAL SOCIETY

May 15, 1941. Meeting, 2093 Life Sciences Building, University of California, Berkeley, at 7:45 P. M. Dr. G. Ledyard Stebbins, Jr., Chairman of the Program Committee, occupied the chair. Dr. Norman H. Boke, of the University of California Botanical Garden, Berkeley, gave a lecture on "The Structure of the Cactus Plant." The talk was illustrated by prepared sections of cactus tissue, shown through a microprojector, and by a collection of representative cactaceous genera loaned by Mr. Jack Whitehead.

September 18, 1941. Meeting, 2093 Life Sciences Building, University of California, Berkeley, at 7: 45 P. M. The President, Professor E. B. Babcock, occupied the chair. Dr. Ralph Emerson, Instructor in Botany, University of California, Berkeley, presented an illustrated lecture on, "An Interpretation of the 'New Systematics' in the Lower Fungi."

October 16, 1941. Meeting, 2503 Life Sciences Building, University of California, Berkeley, at 7: 45 P. M. The President, Professor E. B. Babcock, occupied the chair. The President appointed a Membership Committee, consisting of Dr. Alan A. Beetle, Dr. Ralph Emerson and Dr. Reed C. Rollins. Mr. E. Yale Dawson, Teaching Assistant in Botany, University of California, Berkeley, presented an illustrated lecture on, "Exploring for Algae in the Gulf of California."

November 27, 1941. Meeting, 2093 Life Sciences Building, University of California, Berkeley, at 7: 45 P. M. The President, Professor E. B. Babcock, occupied the chair. Professor H. E. McMinn, Chairman of the Nominating Committee, submitted the names of the following candidates: President, Dr. Alva R. Davis; First Vice-President, Dr. Palmer Stockwell; Second Vice-President, Dr. Reed C. Rollins; Secretary, Dr. Mildred E. Mathias; Treasurer, Dr. William M. Hiesey. A motion, made and seconded, to accept the report of the nominating committee, was passed unanimously. There were no nominations from the floor. Dr. Howard S. Reed, Professor of Plant Physiology, University of California, Berkeley, presented an illustrated lecture on, "The Migrations of the Citrus Fruits."

Following are the names of persons who have affiliated with the California Botanical Society since the publication of the list of members, April, 1940: Dr. Gordon D. Alcorn; Dr. Vada H. Allen; Mr. William H. Baker; Dr. Fred A. Barkley; Dr. J. T. Barrett; Mr. Kay H. Beach; Mrs. Margaret K. Bellue; Mr. W. Sidney Boyle; Dr. Muriel Bradley; Mr. Conrad M. Brown; Mr. Alfred J. Burrows; Dr. Marion S. Cave; Dr. Walter P. Cottam; Dr. Alden S. Crafts; Dr. Robert A. Darrow; Miss Bernice E. Doyel; Mr. M. B. Dunkle; Mr. Erl H. Ellis; Dr. Ralph Emerson; Dr. Katherine Esau; Professor A. O. Garrett; Mr. M. French Gilman; Dr. T. Harper Goodspeed; Mr. Arthur H. Holmgren; Mr. J. Wendell Howe; Mrs. Lilla Leach; Mr. Harlan Lewis; Dr. W. H. Long; Mr. Elmer Lorenz; Mr. Gregory S. Lyon; Miss Lois McCasky; Mr. James B. McNair; Mr. Oliver V. Matthews; Mr. Roy D. Metcalf; Mr. Reid Moran; Mr. Thomas Morley; Dr. W. C. Muenscher; Mr. David G. Nichols; Mrs. Doris K. Niles; Mr. M. A. Nobs; Mr. Donald Culross Peattie; Mr. Frank W. Peirson; Mr. R. L. Piemeisel; Dr. Ethel I. Sanborn; Dr. Michael Shapovalov; Mr. Edward Stuhl; Miss Helen Talbot; Mr. John M. Tucker.—Lincoln Constance, Secretary.